CLAIMS

1. A sound-wave imaging method including at least one emission step during which a first array (5) of transducers is caused to emit at least one ultrasound excitation wave presenting a certain central emission frequency f_c and focused on at least one target point (4) in a target medium (2), and said excitation wave is caused to pass through a reverberant medium (7) prior to reaching the target medium (2),

the method being characterized in that during the emission step, a reverberant solid object (7) is used as the reverberant medium, with each transducer (6) of the first array (5) being secured thereto, said reverberant solid object (7) being adapted to give rise to multiple reflections of the excitation wave that passes therethrough and to cause an impulse wave of duration $1/f_c$ entering into said solid object to lead to sound emission to the target medium taking place over a duration of not less than $10/f_c$.

2. A method according to claim 1, in which during the emission step, the excitation wave s(t) is emitted towards a number K not less than 1 of predetermined target points <u>k</u> belonging to the target medium, by causing each transducer <u>i</u> of the first array (5) to emit an emission signal:

$$s_i(t) = \sum_{k=1}^{K} e_{ik}(t) \otimes s(t)$$

where the signals $e_{ik}(t)$ are predetermined individual emission signals adapted so that when the transducers <u>i</u> emit the signals $e_{ik}(t)$, an impulse sound wave is generated at the target point <u>k</u>.

3. A method according to claim 2, in which the signals $e_{ik}(t)$ are encoded on a number of bits lying in the range 1 to 64.

4. A method according to claim 3, in which the signals $e_{ik}(t)$ are coded on 1 bit.

5. A method according to any one of claims 2 to 4, in which the individual emission signals $e_{ik}(t)$ are determined experimentally during a training step, prior to said emission step.

6. A method according to claim 5, in which during the training step, an ultrasound impulse signal is caused to be emitted successively from each predetermined target point <u>k</u>, the signals $r_{ik}(t)$ received by each of the transducers <u>i</u> of the first array (5) from the emission of said ultrasound impulse signal are picked up, and the individual emission signals $e_{ik}(t)$ are determined by time reversal of the received signals $r_{ik}(t)$:

$$e_{ik}(t) = r_{ik}(-t)$$

7. A method according to claim 6, in which, during the training step, a liquid medium different from the target medium (2) is put into contact with the reverberant solid object (7), and said impulse signal is caused to be emitted from said liquid medium.

8. A method according to claim 5, in which, during the training step, for a predetermined target point <u>k</u>, an ultrasound impulse signal is caused to be emitted in succession from each of the transducers <u>i</u> of the first array, the signals $r_{ik}(t)$ received at the target point <u>k</u> from the emission of said ultrasound impulse signals are picked up, and the individual emission signals $e_{ik}(t)$ are determined by time reversal of the received signals $r_{ik}(t)$:

$$e_{ik}(t) = r_{ik}(-t)$$

9. A method according to claim 8, in which, during the training step, a liquid medium different from the target medium (2) is put into contact with the reverberant solid object (7), and the signals $r_{ik}(t)$ are picked up in said liquid medium.

10. A method according to claim 7 or claim 9, in which the liquid medium used during the training step essentially comprises water, and in which during the emission step, the target medium (2) in which the excitation wave is focused comprises at least a portion of the body of a patient.

11. A method according to any one of claims 2 to 4, in which the individual emission signals $e_{ik}(t)$ are determined by calculation.

12. A method according to any preceding claim, in which the reverberant solid object (7) through which the excitation wave is caused to pass during the emission step is in contact with the target medium (2).

13. A method according to any preceding claim, further comprising a step of receiving echoes emitted by the target medium (2) in response to the excitation wave, in order to image at least a portion (3) of said target medium.

14. A method according to claim 13, in which the excitation wave is emitted for a duration lying in the range $1/2f_c$ to $10/f_c$.

15. A method according to claim 13 or claim 14, in which:

· during the emission step, the excitation wave passes through at least one acoustically non-linear medium (2) and presents an amplitude that is sufficient for waves that are harmonics of the central emission

frequency to be generated in said acoustically non-linear medium; and

· during the reception step, echoes returned from the target medium (2) are picked up at a receive frequency that is an integer multiple of the central emission frequency.

16. A method according to claim 15, in which the harmonic waves are generated in the target medium (2), which presents non-linear acoustic behavior.

17. A method according to claim 15 or claim 16, in which, during the reception step, the echoes returning from the target zone (2) are picked up at a receive frequency equal to two or three times the central emission frequency.

18. A method according to any one of claims 13 to 17, in which, during the emission step, the target medium (2) in which the excitation wave is focused comprises at least a portion of the body of a patient.

19. A method according to any one of claims 13 to 18, in which, during the reception step, the echoes returning from the target zone (2) are picked up by means of a second array (9) of transducers secured to said reverberant solid object (7).

20. A method according to any one of claims 1 to 12, in which, during the emission step, an amplitude modulated excitation wave is emitted that is adapted to apply radiation pressure on the target medium (2) to generate a low frequency shear wave.

21. A method according to claim 20, in which, during the emission step, the target medium (2) in which the

excitation wave is focused, comprises at least a portion of the body of a patient.

22. A method according to any one of claims 1 to 12, in which, during the emission step, an excitation wave is emitted that is adapted to heat the target medium (2) locally.

23. Sound-wave imaging apparatus comprising at least emitter means (11, 5) comprising a first array (5) of transducers, said emitter means being adapted to cause at least one ultrasound excitation wave to be emitted by the first array of transducers through a reverberant medium (7), the emitted wave presenting a certain central emission frequency f_c and being focused on at least one target point (4) of a target medium (3),

the apparatus being characterized in that the reverberant medium comprises a reverberant solid object (7) having each of the transducers (6) of the first array (5) secured thereto, said reverberant solid object being adapted to give rise to multiple reflections of the excitation wave passing therethrough and to cause an impulse wave of duration $1/f_c$ entering said solid object to lead to sound being emitted towards the target medium over a duration of not less than $10/f_c$.

24. Apparatus according to claim 23, in which, the emitter means (11, 5) are adapted to cause the excitation wave s(t) to be emitted to a number K not less than 1 of predetermined target points $\underline{k}$ belong to the target medium (2), by causing each transducer $\underline{i}$ of the first array (5) to emit an emission signal:

$$s_i(t) = \sum_{k=1}^{K} e_{ik}(t) \otimes s(t)$$

where the signals $e_{ik}(t)$ are predetermined individual emission signals adapted so that when the transducers $\underline{i}$

emit the signals $e_{ik}(t)$, an impulse sound wave is generated at the target point $\underline{k}$.

25. Apparatus according to claim 23 or claim 24, further comprising receiver means (11, 9) for receiving echoes emitted by the target medium (2) in response to the excitation wave in order to image at least a portion (3) of said target medium.

26. Apparatus according to claim 25, in which the emitter means are adapted to emit the excitation wave for a duration lying in the range $1/2f_c$ to $10/f_c$.

27. Apparatus according to claim 25 or claim 26, in which the receiver means (11, 9) are adapted to receive to the echoes returning from the target medium (2) at a receive frequency that is an integer multiple of the central emission frequency.

28. Apparatus according to claim 27, in which the receiver means (11, 9) are adapted to receive the echoes returning from the target medium (2) at a receive frequency equal to twice the central emission frequency.

29. Apparatus according to any one of claims 26 to 28, in which the receiver means (11, 9) comprise a second array (9) of transducers secured to said reverberant solid object (7).

30. Apparatus according to any one of claims 23 to 25, in which the emitter means (11, 5) are adapted to emit an excitation wave adapted to apply radiation pressure on the target medium (2).

31. Apparatus according to any one of claims 23 to 25, in which the emitter means (11, 5) are adapted to emit an

excitation wave adapted to heat the target medium (2) locally.